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Research Paper

Estimating the difference of agriculture productivity in ASIAN regions

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Abstract

Agriculture is the major sector in the economy of Asia. The aim of this paper is to identify the importance of agriculture in Asia continent. In this paper, we evaluate differences between and within regions of Asia (Eastern-Asia, South-Central Asia, South-East Asia, and Western Asia and Middle Asia) and their countries. We used five agriculture parameters (Agriculture Land, Cereal production, Machinery, Tractors, Cereal yield, Land under cereal production) which widely represent agriculture productivity of Asia. The means of all Asian regions and its countries are identically similar is considered as a hypothesis for agriculture parameters. We use One-way ANOVA (analysis of variance) technique for analysis. Further, Asian regions and countries are estimated to test the differences of the means between and within regions and countries of each Asian region. The results show that each Asian region and their countries are having different agriculture productivity for agriculture parameters.

Keywords: *Asia; Agriculture Productivity; Economic Growth.*

1. Introduction

ASIA is the Earth's largest continent, located primarily in the eastern and northern hemispheres. Asia covers an area of 44,579,000 square kilometres, about 30% of Earth's total land area and 8.7% of the Earth's total surface area. It is geopolitically and strategically important because of its geographic position shown in Fig. 1. Agriculture is one of the most important sources of earning for majority of main-workers living in countries of Asian continent and contributes in the economy growth in terms of GDP and exports. The agriculture productivity is depends on fertile regions. Agriculture growth depends on various parameters such as Agriculture Land [1], Cereal production [2], Machinery-Tractors [3], Cereal yield, and Land under cereal production [4]. Agriculture land refers to the share of land area that is arable, under permanent crops, and under permanent pastures. It includes 48% in Eastern-Asia, 67.6% in South-Central Asia, 56.8% in South-East Asia, and 22.8% in Western and Middle Asia. Machinery-Tractors help to increase food production in agricultural sector which leads to growth in consumption of pesticides, global inorganic fertilizer and animal feedstuffs etc. It also helps to increase cereal yield and its production. Cereal yield measured as kg per hectare of harvested land including wheat, rice, maize, barley, oats, rye, millet etc. Land under cereal production refers to harvested area in region. The temperature variations though periodic nature may vary from region to region and such variations are mainly dependent on location and altitude of the region and also on other factors like the nearness of sea and vegetation. Sometimes the agriculture productivity of different regions are different because of its temperature, air pressure, humidity etc variations. Anita et. al. analyzed such periodic variations using recurrence plot (RP), cross recurrence plot (CRP), recurrence rate (RR), and correlation of probability of recurrence (CPR) methods to find similarities between and within united states climatic regions and to identify their connectivity trend [5]. Information and Communication technology (ICT) is the efficient way to increase the productivity of agriculture. They extract the useful knowledge based content and identifying the patterns in dataset for identifying the important features in agricultural domain. Pallavi ET. Al. build an information system for improving interaction between farmer and customer to analyze and use of data mining technique specially regression analysis to predict the crop production to have decision-making process easier [6]. The other parameters like fertilizer, modern seeds and water are playing a key role in boosting yields. Jonh ET. Al. presented and test for respective empirical links between agricultural yields and economic growth, labor share in agriculture and non-agricultural value added per worker [7].

The primary goal of this work is to estimate the agriculture productivity in terms of cereal production in Asian regions. From literature [8], [9], [10] we identify parameters which effect the production of agriculture. Since the economy of all region in Asia is different. Therefore, we try to find the countries or regions where difference exists between them in terms of agriculture production. We are doing this by identifying gap between and within regions and countries of each Asian region.

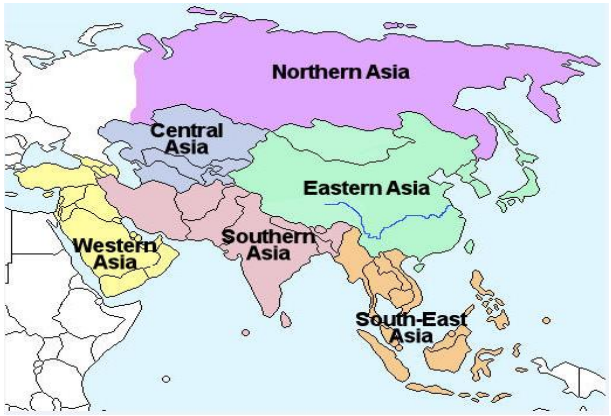


Fig 1: Asia Regions.

The rest of the paper is organized as follows. Section II introduces details of the used dataset and adopted methods. Section III describes the experiments and results for asian regions. The conclusion and a brief discussion of opportunities for future work are presented in Section IV.

2. Methodology: anova and z-statistics

2.1. Dataset

Yearly data on agriculture parameters for 54 years (1960–2014) were collected from the World Bank data for Asian regions: Eastern-Asia, South-Central Asia, South-East Asia, and Western Asia and Middle Asia and their countries. The data has been transformed to normalized form. Table I, describes the World Bank data sample dataset use for further processing.

Table 1: Used Dataset

Agriculture Parameters/ Years	1991	1992	1993	1994	1995
Agriculture Land	2025	2085	2116	2112	1926
Cereal production (metric tons)	193101196	201468404	208626900	211941400	2100125500
Machinery-Tractors	65.5	70.1	73.7	77.6	83.8
Cereal yield (kg per hectare)	1926	2025	2085	2116	2112
Land under cereal production	100243408	99499504	100066500	100184200	99450800

The variables are: Agriculture Land, Cereal production (metric tons), Machinary, Tractors, Cereal yield (kg per hectare), and Land under cereal production for four Asian regions: Eastern-Asia (5 countries), South-Central Asia (10 countries), South-East Asia (8 countries), and Western Asia and Middle Asia (12 countries) as follows:

Eastern-Asia: China, Japan, Korea, Rep., Korea, Dem. Rep. and Mongolia

South-Central Asia: Afghanistan, Bangladesh, Bhutan, India, Iran, Islamic Rep., Maldives, Nepal, Pakistan, Srilanka.

South-East Asia: Brunei-Darussalam, Combodia, Indonesia, Malaysia, Myanmar, Philippines, Thailand, Vietnam.

Western Asia and Middle Asia: Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Turkey, United Arab Emirates, Yemen.

We selected the One way ANOVA technique to examine the difference between region and countries of each Asian region. For results calculation, we evaluate the mean and variance for agriculture parameter as follows:

Here we are showing the formula for a country with respect to one Asian region.

p_{mn}, parameter pin year m for country n; n=1, 2.., N.

R_i, i^{th} Asian region.

S_n , size of n^{th} country in region R_i,

$\bar{p}_n$, sample mean of n^{th} country in region R_i,

$\bar{\bar{p}}$, grand mean of parameter for n^{th} country,

N, number of countries in region R_i. For example South-Central Asia region N=10.

$S_T = \sum S_n$, Total country size,

s_n^2 , sample arithmetic variance for country n in region R_I,

σ_b^2, variance between countries in region R_I (e.g. between India and Srilanka countries in South-Central Asia region),

σ_w^2, variance within country of region R_I (e.g. within India)

Arithmetic mean of parameter p for country n in region R_I is:

$$\bar{p}_n = \sum_m \frac{p_{mn}}{S_n}, \text{where } m = 1, , \dots, S_n \quad (1)$$

Arithmetic variance for country n in region R_I is:

$$s_n^2 = \frac{\sum_m (p_{mn} - \bar{p}_n)^2}{(S_n - 1)}, \text{where } m = 1, 2, \dots, S_n \quad (2)$$

Grand mean $\bar{\bar{p}}$ is:

$$\bar{\bar{p}} = \sum_m \sum_n p_{mn} / S_T \quad (3)$$

a) Calculation of Analysis of variance (ANOVA) [11],[12]:

Sum of squares (TS) of a parameter p calculated as sum of variation between countries (SB) and within countries (SW).

$$TS = SB + SW \quad (4)$$

Where,

$$SB = \sum S_n (\bar{p}_n - \bar{\bar{p}})^2 \quad (5)$$

And

$$SW = \sum_m (S_n - 1) s_n^2 \quad (6)$$

Evaluation of variance between countries (MSB):

$$\sigma_b^2 = \frac{\sum S_n (\bar{p}_j - \bar{\bar{p}})^2}{N - 1} \quad (7)$$

Or

$$MSB = \frac{SB}{N-1} \quad (8)1$$

Evaluation of variance within country (MSW):

$$\sigma_w^2 = \sum_n \left(\frac{S_n - 1}{S_T - N}\right) s_n^2 \quad (9)$$

Or

$$MSW = \frac{SW}{S_T - N} \quad (10)$$

b) F-test statistics

To test the similarity in all countries of Region R_I for a parameter p is:

$$F = MSB/MSW \quad (11)$$

MSB and MSW is calculated using Eq. (8) and (10). For significance testing (α=0.05), we compared calculated F value with its F_{crit} (α, k-1, S_T -k) value.

If the hypothesis of similarity of means is rejected, a question comes that which means are unequal. Various paired comparison is performed to solve this question. This comparison is evaluated using z-test (two tailed significance level) [11] with hypothesis at α=0.05 significance level. Hypothesis indicates that there is no difference between agriculture related parameters of countries of each Asian region vs. each country of same region.

Hypothesis, $H_0: \mu_1 = \mu_2$, Null Hypothesis, there is no differences exists,
$H_1: \mu_1 \neq \mu_2$, Alternative Hypothesis, differences exists.
Z-test Statistics are

$$z = \frac{(\overline{p_a} - \overline{p_n}) - (\mu_1 - \mu_2)_{H_0}}{\sigma_{p_a - p_n}} \quad (12)$$

Where,
n=1, 2, 10 indicates all countries in South-Central Asia region,
p_a, means of all countries in South-Central Asia region,
$\sigma_{p_a - p_n}$, Standard error of the difference between two means,
And $\sigma_{p_a - p_n}$ is calculated as,

$$\sigma_{p_a - p_n} = \sqrt{\frac{\sigma_1^2}{S_1} + \frac{\sigma_2^2}{S_2}} \quad (13)$$

Where σ_1 and σ_2 are calculated from Eq. (2) and
σ_1^2 , indicates variance of all countries in South-Central Asia region
σ_2^2, indicates variance of one country in South-Central Asia region
Fig. 2, describes Two-tailed hypothesis test of the difference between two means at the 0.05 significance level and represents hypothesis test graphically. Region outside the both vertical lines contains 0.025 of the area. The acceptance region range ($-1.64 \leq z \leq +1.64$) within vertical lines contains two equal areas of 0.475 each. We determine the critical value of z using standard table [11]. For e.g. we can see that the calculated z value 3.86 lies outside the range i.e. hypothesis is not accepted.
Eq. (5), (6) and (11) are used to evaluate Table II shows the ANOVA results represents SB, SW and TS which indicates their percentage of contribution for each agriculture parameter. The differences between Asian regions and the countries of each Asian region are much smaller than the differences within them.

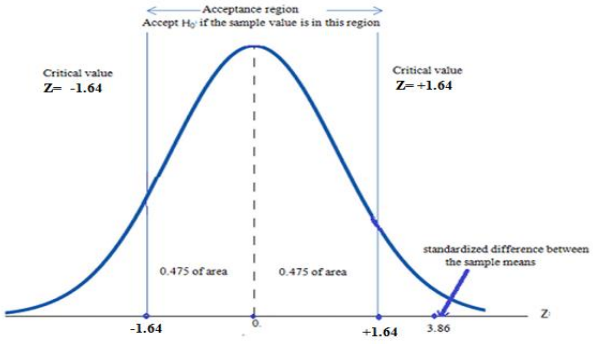


Fig. 2: Two-Tailed Hypothesis Test.

3. Experimental evaluation

A number of significant experiments were performed to verify the effectiveness and efficiency of the proposed approach. All our experiments were conducted on a Intel(R) Core(TM) i3 CPU@2.10GHz processor with 3 GB of RAM and running on a Windows 7 OS. The algorithm in the experiments were implemented in Java.

2.1. Results

Table II showing the ANOVA results. We observed from results that when examining Cereal yield in Asian regions, where group of Asian region describes only 14.42 % of the difference and 85.57 % of the differences present within them. Agriculture Land shows maximum 78% (approx.) difference between Asian regions. Similarly, for South Central Asia region we observed that Cereal yield, where only 3.29 % of the difference is described by group of South Central Asia region countries and 96.7 % of the differences present within the country. Agriculture Land shows maximum 38% (approx.) difference between countries. The indica-tion is that large differences exist between regions and countries for various parameters, which can explain region and country's level agriculture productivity.
F-statistic is evaluated using Eq. (11), we notice that the F-test statistic value exceeds the significance level of F_crit (0.05) except Cereal yield parameter.
The results describes in Table III and Table IV calculated using Eq. (12), represent the results of testing for differences between Asian regions Vs each Asia region and countries of South Central Asia region Vs a country in a region for the five agriculture parameters. Each region and country is significantly different from the group of all regions and countries. From Table IV, we observed that Cereal yield is the only parameter where we did not get any exception. For Cereal production parameter, we got exception in two countries as Bhutan and Maldives. Similarly, we got the exceptions for other agriculture parameters in countries. This provides strong conclusion for each region and country uniqueness in five agriculture parameters. Table V describes the various paired comparison for Eastern Asia and similarly determine the Z-test for South East Asia and Western Asia and Middle East regions.

Table 2: Anova Results

All Asian regions						
Agriculture Parameters	SB	%TS	SW	%TS	F-Statistics	F-critical
Agriculture Land	931.70	78.4	256.15	21.5	250.97	1.958
Cereal production	109.35	17.0	532.51	82.9	14.23	1.958
Machinery, Tractors	264.47	19.5	1090.8	80.4	16.80	1.958
Cereal yield	131.32	14.4	779.06	85.5	11.68	1.958
Land under cereal production	187.10	41.7	261.19	58.2	49.66	1.958
Eastern-Asia						
Agriculture Land	0.472	7.37	5.924	92.5	5.178	1.958
Cereal production	0.731	4.29	16.288	95.6	2.919	1.958
Machinary, Tractors	5.143	15.0	28.953	84.9	11.54	1.958
Cereal yield	1.421	7.70	17.029	92.2	5.426	1.958
Land under cereal production	4.494	18.2	20.102	81.7	14.532	1.958
South-East Asia						
Agriculture Land	2.73	16.5	13.789	83.4	11.77	1.958
Cereal production	2.052	5.91	32.639	94.0	3.737	1.958
Machinary, Tractors	5.637	13.9	34.741	86.0	9.644	1.958
Cereal yield	0.775	2.18	34.664	97.8	1.328	1.958
Land under cereal production	3.766	10.2	33.056	89.7	6.771	1.958
South Central Asia						
Agriculture Land	6.0711	38.4	9.7202	61.6	36.53	1.958
Cereal production	6.1854	15.5	33.699	84.4	10.73	1.958
Machinary, Tractors	7.2879	14.2	43.709	85.7	9.753	1.958

Cereal yield	1.1886	3.29	34.827	96.7	1.896	1.958
Land under cereal production	11.594	28.0	29.801	71.9	22.76	1.958
Western Asia and Middle Asia						
Agriculture Land	9.905	37.6	16.379	62.3	34.304	1.958
Cereal production	11.552	20.9	43.557	79.0	15.044	1.958
Machinary, Tractors	4.704	6.30	69.884	93.6	3.818	1.958
Cereal yield	11.576	21.9	41.207	78.0	15.936	1.958
Land under cereal production	9.282	17.5	43.612	82.4	12.074	1.958

Table 3: Asian Regions: Various Paired Comparisons

Paired Comparison	Z- test Stastics	Decision
Agriculture Land		
All Asian Region vs Western Asia and Middle Asia	29.21947	Hypothesis rejected
All Asian Region vs South-East Asia	37.09627	Hypothesis rejected
All Asian Region vs South Central Asia	33.72663	Hypothesis rejected
All Asian Region vs Eastern-Asia	40.79021	Hypothesis rejected
Cereal production (metric tons)		
All Asian Region vs Western Asia and Middle Asia	11.13432	Hypothesis rejected
All Asian Region vs South-East Asia	12.60577	Hypothesis rejected
All Asian Region vs South Central Asia	11.91972	Hypothesis rejected
All Asian Region vs Eastern-Asia	14.44158899	Hypothesis rejected
Machinary, Tractors		
All Asian Region vs Western Asia and Middle Asia	4.824517	Hypothesis rejected
All Asian Region vs South-East Asia	7.312798	Hypothesis rejected
All Asian Region vs South Central Asia	7.170274	Hypothesis rejected
All Asian Region vs Eastern-Asia	7.776551	Hypothesis rejected
Cereal yield (kg per hectare)		
All Asian Region vs Western Asia and Middle Asia	8.734273	Hypothesis rejected
All Asian Region vs South-East Asia	10.0721	Hypothesis rejected
All Asian Region vs South Central Asia	9.931016	Hypothesis rejected
All Asian Region vs Eastern-Asia	11.31569249	Hypothesis rejected
Land under cereal production		
All Asian Region vs Western Asia and Middle Asia	39.27122	Hypothesis rejected
All Asian Region vs South-East Asia	38.08465	Hypothesis rejected
All Asian Region vs South Central Asia	7.85059	Hypothesis rejected
All Asian Region vs Eastern-Asia	45.21334	Hypothesis rejected

Table 4: South Central Asia (Sca) Region: Various Paired Comparisons

Paired Comparison	Z- test Stastics	Decision
Agriculture Land		
All SCA Countries vs Afganistan	4.243096	Hypothesis rejected
All SCA Countries vs bangladesh	1.610639	Hypothesis accepted
All SCA Countries vs Bhutan	-0.97731	Hypothesis accepted
All SCA Countries vs India	3.98043	Hypothesis rejected
All SCA Countries vs Iran Islam	1.061054	Hypothesis accepted
All SCA Countries vs Maldives	-9.5113	Hypothesis rejected
All SCA Countries vs Nepal	2.266788	Hypothesis rejected
All SCA Countries vs Pakistan	1.955308	Hypothesis rejected
All SCA Countries vs Shrilanka	-0.69711	Hypothesis accepted
Cereal production (metric tons)		
All SCA Countries vs Afganistan	1.138667	Hypothesis accepted
All SCA Countries vs bangladesh	-0.51677	Hypothesis accepted
All SCA Countries vs Bhutan	2.388541	Hypothesis rejected
All SCA Countries vs India	1.478581	Hypothesis accepted
All SCA Countries vs Iran Islam	0.991198	Hypothesis accepted
All SCA Countries vs Maldives	-8.21656	Hypothesis rejected
All SCA Countries vs Nepal	-0.86693	Hypothesis accepted
All SCA Countries vs Pakistan	1.161414	Hypothesis accepted
All SCA Countries vs Shrilanka	0.369551	Hypothesis accepted

Machinary, Tractors		
All SCA Countries vs Afganistan	2.227697	Hypothesis rejected
All SCA Countries vs bangladesh	3.813452	Hypothesis rejected
All SCA Countries vs Bhutan	-1.23192	Hypothesis accepted
All SCA Countries vs India	-0.59357	Hypothesis accepted
All SCA Countries vs Iran Islam	0.844348	Hypothesis accepted
All SCA Countries vs Maldives	-10.0161	Hypothesis rejected
All SCA Countries vs Nepal	-2.30007	Hypothesis rejected
All SCA Countries vs Pakistan	0.817903	Hypothesis accepted
All SCA Countries vs Shrilanka	0.499199	Hypothesis accepted
Cereal yield (kg per hectare)		
All SCA Countries vs Afganistan	1.026758	Hypothesis accepted
All SCA Countries vs bangladesh	-0.30483	Hypothesis accepted
All SCA Countries vs Bhutan	-1.4291	Hypothesis accepted
All SCA Countries vs India	0.797611	Hypothesis accepted
All SCA Countries vs Iran Islam	0.184585	Hypothesis accepted
All SCA Countries vs Maldives	-1.63341	Hypothesis accepted
All SCA Countries vs Nepal	0.479595	Hypothesis accepted
All SCA Countries vs Pakistan	1.363809	Hypothesis accepted
All SCA Countries vs Shrilanka	-0.47498	Hypothesis accepted
Land under cereal production		
All SCA Countries vs Afganistan	-1.06203	Hypothesis accepted
All SCA Countries vs bangladesh	1.460219	Hypothesis accepted
All SCA Countries vs Bhutan	1.139559	Hypothesis accepted
All SCA Countries vs India	1.419649	Hypothesis accepted
All SCA Countries vs Iran Islam	3.948601	Hypothesis rejected
All SCA Countries vs Maldives	-15.1088	Hypothesis rejected
All SCA Countries vs Nepal	1.050159	Hypothesis accepted
All SCA Countries vs Pakistan	1.841721	Hypothesis rejected
All SCA Countries vs Shrilanka	0.420295	Hypothesis accepted

Table 5: Eastern Asia (Ea) Region: Various Paired Comparisons

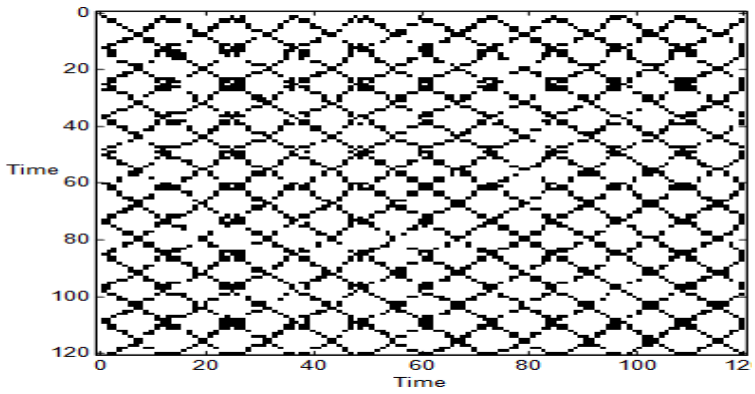
Paired Comparison	Z- test Stastics	Decision
Agriculture Land		
All Eastern Asian Countries vs Mangolia	1.887144	Hypothesis rejected
All Eastern Asian Countries vs Korea Dm	10.11009	Hypothesis rejected
All Eastern Asian Countries vs Korea Rep	1.421297	Hypothesis accepted
All Eastern Asian Countries vs Japan	-4.5138	Hypothesis rejected
All Eastern Asian Countries vs China	-1.0378	Hypothesis accepted
Cereal production (metric tons)		
All Eastern Asian Countries vs Mangolia	-0.43037	Hypothesis accepted
All Eastern Asian Countries vs Korea Dm	-1.40041	Hypothesis accepted
All Eastern Asian Countries vs Korea Rep	-0.23692	Hypothesis accepted
All Eastern Asian Countries vs Japan	0.270288	Hypothesis accepted
All Eastern Asian Countries vs China	2.325762	Hypothesis rejected
Machinary, Tractors		
All Eastern Asian Countries vs Mangolia	2.707213	Hypothesis rejected
All Eastern Asian Countries vs Korea Dm	-2.75683	Hypothesis rejected
All Eastern Asian Countries vs Korea Rep	-3.86944	Hypothesis rejected
All Eastern Asian Countries vs Japan	1.39006	Hypothesis accepted
All Eastern Asian Countries vs China	1.296821	Hypothesis accepted
Cereal yield (kg per hectare)		
All Eastern Asian Countries vs Mangolia	-0.0765	Hypothesis accepted
All Eastern Asian Countries vs Korea Dm	-3.05113	Hypothesis rejected
All Eastern Asian Countries vs Korea Rep	1.909156	Hypothesis rejected
All Eastern Asian Countries vs Japan	-0.72685	Hypothesis accepted
All Eastern Asian Countries vs China	1.222868	Hypothesis accepted
Land under cereal production		
All Eastern Asian Countries vs Mangolia	0.279463	Hypothesis accepted
All Eastern Asian Countries vs Korea Dm	2.20095	Hypothesis rejected
All Eastern Asian Countries vs Korea Rep	-0.40873	Hypothesis accepted
All Eastern Asian Countries vs Japan	-4.43796	Hypothesis rejected
All Eastern Asian Countries vs China	3.522413	Hypothesis rejected

2.2. Correctness of proposed method

To validate the effectiveness and reliability of our approach we are using recurrence quantification analysis (recurrence plot, cross recurrence plots) [5] and association rules methods [13]. The recurrence plot and cross recurrence plots are shown in Fig. 3. From Fig. 3(a) we can see that RP of South-East Asia region have similar periodic variations which indicate that the occurrence of recurrent points along the main diagonal for each region is same. It means the temperature of one region follows some periodic variation which is different from another region. From Fig. 1 we can see that Central asian and South-East Asia regions are situated diagonally, so very less similarity will appear in their temperature. In other words, in the case of Central asian and South-East Asia regions sun rays have the direct impact on Central asian and less on South-East Asia regions, so there temperature differs which is shown by less correlated number of points in CRP, Fig. 3(b).

It indicates the weak similarity between Central Asian and South-East Asia regions. We know that the agriculture productivity is directly depends on the temperature of regions. So if climate temperature is differ in regions, agriculture productivity also found to be dissimilar in different regions as shown in Fig. 3.

Recurrence Plots for South-East Asia.



Cross Recurrence Plots for Central and South-East Asia.

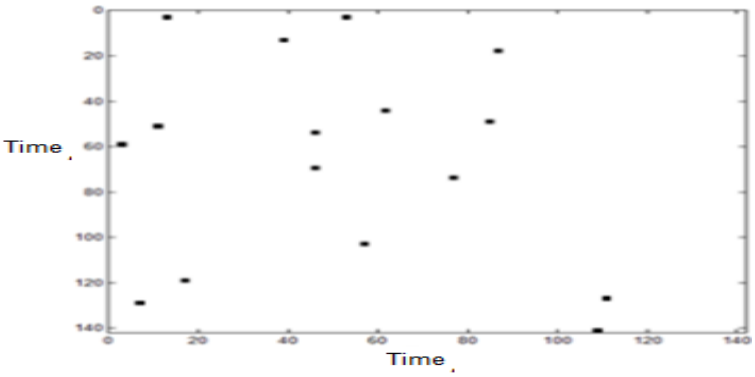


Fig. 3: Recurrence Plots and Cross Recurrence Plots.

Table6: iassociation Rules on Correlated Parameters

Asian Regions	Rules	Support	Strength
Eastern-Asia	(AGL, D, 4%, 3) ⇒ (CP, 1%)	73	126.29
	(LUCP, D, 1.2%, 1) ⇒ (CP, 3%)	71	122.83
	(CY, D, 1%, 2) ⇒ (CP, 3%)	68	117.64
	(MT, D, 3%, 2) ⇒ (CP, 1%)	70	121.01
South-Central Asia	(AGL, D, 4.5%, 3) ⇒ (CP, 2.5%)	72	128.02
	(LUCP, D, 0.8%, 1) ⇒ (CP, 2%)	73	129.75
	(CY, D, 5%, 2) ⇒ (CP, 2.5%)	72	124.5
	(MT, D, 3%, 2) ⇒ (CP, 2%)	76	131.48
South-East Asia	(AGL, D, 4.5%, 3) ⇒ (CP, 2%)	73	126.29
	(LUCP, D, 1%, 1) ⇒ (CP, 2.8%)	74	128.02
	(CY, D, 1.2%, 2) ⇒ (CP, 2.4%)	70	121.1
	(MT, D, 2%, 2) ⇒ (CP, 0.8%)	69	119.31
Western Asia and Middle Asia	(AGL, D, 4%, 3) ⇒ (CP, 0.8%)	70	121.1
	(LUCP, D, 1.5%, 1)⇒ (CP, 3.5%)	68	117.64
	(CY, D, 1.5%, 2) ⇒ (CP, 2.8%)	67	115.91
	(MT, D, 3%, 2) ⇒ (CP, 5%)	71	122.83

Where, AGL: Agriculture Land, LUCP: Land under cereal production, CP: Cereal production, MT: Machinary-Tractors, CY: Cereal yield, D: Direct relationship.

In Table VI causal relationship between parameters is described with its support, strength and rate of change

For generated rules. For example, a rule (AGL, D, 4%, 3) ⇒ (CP, 1%), indicates direct relationship, i.e. increase in agriculture land by 4%, will increase the crop production index by 1 % after 3 years. From Table VI we can observe that the different regions having different support, strength and rate of change for similar rules because of various economic conditions which affects the agriculture productivity of asian regions.

4. Conclusion

The result of our analysis indicates that significant gap exists between and within Asian regions as well as their countries. Regardless of serving as an active body (Asian-continent) in world, there exist economic differences between regions and its countries. We used ANOVA and z test to perform necessary evaluations on 54 years time series data. Our main contribution is to test the differences among Asian regions (Eastern-Asia (5 countries), South-Central Asia (10 countries), South-East Asia (8 countries), and Western Asia and Middle Asia (12 countries)) and their counties using five parameters (Agriculture Land, Cereal production, Machinery, Tractors, Cereal yield, Land under cereal production). From our analysis we notice that only cereal yield followed the hypothesis, i.e. there exists similarity between countries of south central Asian region for cereal yield and also identified that other agriculture parameters were not having the similar characteristic. We show that each region and its countries follows unique characteristic for agriculture parameters. Our finding helps to analyse differences exist between region and countries for various parameters which can explain region and country's level agriculture productivity. It also helps to reduce poverty, increase foreign exchange and balance economic growth between Agriculture and Industry.

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